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FORMATION (GENESIS) OF SINKHOLE AND CRATER-LIKE STRUCTURE OF THE EARTH, AS SYNERGISTIC SEISMIC AND IONOSPHERIC PROCESSES

Abstract. The article deals with a hypothesis about the cause of the deep crater-sinkhole in the world and explosions of inexplicable nature. The root cause of these phenomena is a powerful local plasma formations in the ionosphere. They can be caused by both natural factors during periods of high solar activity, and artificial heating of the ionosphere by means of electromagnetic emitters. Local increase and the concentration of plasma formations can occur when stone bolids and the formation of plasmoids enter the ionosphere. Bolid flight, when the electric field between the bolid and electrified corona surface reachs a certain level of intensity, is accompanied by the release of electrically charged particles of the soil and its discharge with the formation of a strong shock wave.

Keywords: craters (downwarping), crater-formation, Yamal sinkhole, gas emissions, Sasovo explosion, earthquake, subzero ionization of the soil, slow seismic waves, bolides, plasmoids, solar activity, seismic activity.

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ОБРАЗОВАНИЕ ПРОВАЛОВ И КРАТЕРОПОДОБНЫХ СТРУКТУР ЗЕМЛИ КАК СОВМЕСТНОЕ ДЕЙСТВИЕ СЕЙСМИЧЕСКИХ И ИОНОСФЕРНЫХ ПРОЦЕССОВ

Аннотация. В статье рассмотрена гипотеза о причине возникновения глубоких кратероподобных провалов в Земле и взрывах необъяснимой природы. Первопричиной этих явлений являются мощные локальные плазменные образования в ионосфере. Они могут быть вызваны как естественными причинами в периоды высокой солнечной активности, так и искусственным разогревом ионосферы с помощью электромагнитных излучателей. Локальное усиление и концентрация плазменных образований может происходить при входе в ионосферу каменных болидов и образовании плазмоидов. Полет болида при достижении определенного уровня напряженности электрического поля, между болидом и наэлектризованной коронирующей поверхностью сопровождается выбросом электрически заряженных частиц грунта и его разрядкой с образованием мощной ударной волны.

Ключевые слова: провалы, кратероподобные образования, Ямальский кратер, выбросы газа, Сасовский взрыв, землетрясение, отрицательная ионизация грунта, медленные сейсмические волны, болиды, плазмоиды, солнечная активность, сейсмическая активность.

Introduction

In recent years, the phenomenon of downwarping is noted in the world, which in some cases has not sufficiently convincing scientific explanation. Except of deep craters that occur in the mining and industrial areas, their occurrence in open and unpopulated spaces rise a number of hypotheses about the causes of this phenomenon and raise the question of the risk of such events and the safety of the population.

The phenomenon of deep sinkholes earth's surface has attracted attention of the public and scientists after the fall of the Chelyabinsk meteorite that fell on the Earth's surface February 15, 2013. Then about of 5–6 large craters were formed, and only in one case, in the lake, a piece of lump was discovered, which is considered to be the remainder of the meteorite. A year after this event in the 10 July 2014 in the tundra on the Yamal Peninsula a sinkhole of land with a diameter of 80–100 and a depth of 45 meters was discovered. A giant hole appeared in the forest in 30 km from the largest industrial base Bovanenkovo on the Yamal Peninsula [8].

In July 2014 in Tazovskiy region of the Yamal-Nenets Autonomous District another such crater was discovered, but of the smaller size – its diameter is approximately 15 meters. It was found by reindeer herders in 90 km from the village Antipayuta and reported to the authorities. These

herders say that in September 2013, in the area some celestial body has dropped, and then there was a flash.

Is a connection between such diverse phenomena possible?

Initially, let's consider the well-known hypothesis of the origin of this sinkhole which is put forward by a number of scientists.

Fig. 1. The Yamal sinkhole

Fig. 2. Yamal crater gradually filled with water

1. Hypotheses and versions about the origin of the Yamal sinkhole

There are following versions and hypothesis of occurrence of the sinkhole [8, 10]:

1. Yamal crater was formed due to the release of gas from the bowels of the earth paleo–frozen soil.
2. The crater was formed when a mixture of water, salt and the gas ignited underground as a result of global warming, says Anna Kurchatova from Subarctic Research Center.
3. "This is a purely mechanical output, which most likely occurred due to increased pressure during freezing and changing of the volume of a cavity, in which there were reserves of swamp gas", — said the participant of research, chief researcher at the Institute of Earth Cryosphere, Siberian Branch of Russian Academy of Sciences, Marina Leybman.
4. Vasiliy Bogoyavlenskiy believes that the "Yamal sinkhole" and many tundra lake with rounded shape on the Yamal Peninsula are thermokarst. The process takes place in areas where paleo-permafrost and underground ice are present. In various regions of the Arctic pingo are formed. "... Gradually, these objects under the influence of solar radiation are destroyed due to the melting of the ice nuclei and form deep lakes with rounded shape. However, they may explode with great force. This phenomenon has been known in the past, but mainly for seasonal pingo. Such formations are fault zones, where the migration and the rise of the gas to the surfacetake place. The phenomenon of the methane degassing occurs constantly, and it happens not only on the land but also in the seas of the Arctic".
5. The head of the geological sector integrated studies "Gazprom VNIIGAZ" Anton Sinitckiy compared Yamal sinkhole with the Bermuda Triangle. According to him, there is a bridge between them — gas hydrates, which consist of methane atoms in stable condition in the molecule of water and are in a frozen state.
6. Vladimir Pavlovich Polevanov, Chief Geologist FBU "Rosgeolekspertiza" considers that cause of the failure is hydrogen accumulation in the cavities and its explosion
7. The staff of the Institute of Petroleum Geology and Geophysics, on the basis of tomography, magnetometry and radiometry, found the connection the two major tectonic faults in the area of the funnel. They could provide additional heating due to heat coming from the Earth's interior. This has led to huge emissions of decomposing gas hydrates, which are found in hundreds of meters from the upper soil layer, and next to it.
8. Crater occurred as a result of the active development of oil and gas deposits and formation of underground cavities Bovanenskoe.
9. The crater was caused due by a meteorite.

To this we must add that Yamal scientists isolated four objects related to gas emissions. Investigation of downwarping and subsequent observations have shown:

- a sinkhole in appearance resembles deep lunar crater with an almost flat bottom;
- the walls of the crater in deeper layers have dark signs of high temperature exposure (Fig. 1) and they are relatively smooth and nearly vertical steep;;
- it is not clear what happened to the total volume of soil from the crater–sinkhole, since there is no any spread of soil around, which always takes place in the ordinary explosion;
- crater–sinkhole is gradually filled with water (up to 10 meters in the winter-spring period of 2014–2015 years), although at the first it was almost empty;

Analysis and evaluation of the above versions of the following conclusions:

1. With modern technology of oil and gas production cavities are formed, and, in practice, at any depth

during production or after, they are filled with water. To initiate fire and explosion large empty space and oxygen are needed that are not formed in the ground. Therefore, the formation of huge cavities and huge volumes of gas accumulation in these is unlikely. Known underground gas storage facilities have been created with the help of underground nuclear explosions, which melted walls off and made them gas-tight.

2. Judging by the volume of the crater-sinkhole, the TNT equivalent of the gas-thermal explosion or the ejection should be not less than 5-10 kT. What, generally speaking, is little achievable with conventional chemical explosion, especially in the natural, and most corresponds to a nuclear explosion. Experts, when nominating their versions of the reasons for the failure or ejection (?), somehow doesn't take this factor into account.
3. It seems that the soil either or evaporated or got up and flew away into space.
4. Status of the lower layers of the crater indicates the presence of high-impact, and a clear contrast and boundary with layers not subjected to such exposure can be seen. So it cannot be at the usual chemical explosion, but it is possible with pulsed electric discharge or electro-plasma exposure.

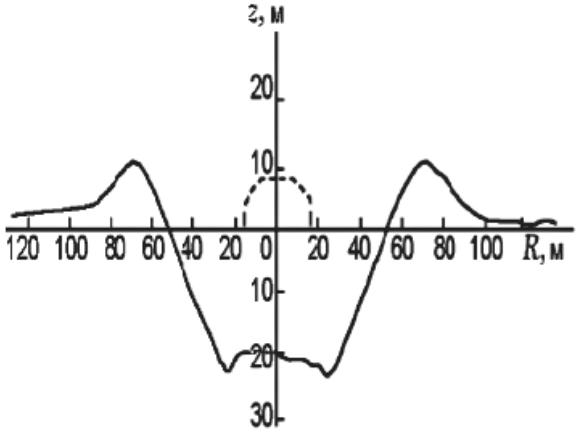

Fig. 3. The typical profile of the crater ground explosive blast with a TNT equivalent of 5000 tons: the radius of the crater on the free surface is 55 m, radius of the crater on the rubble is 70 m, the radius of soil spread is 360 m, pieces of rock range expansion is 1500 meters, the crater depth from the free surface is 21.4 m, the volume of the funnel on the free surface is 120,000 m^3, dashed line — power [1]

2. An analysis of the same phenomenon occurred in Sasovo, April 12, 1991

The present analysis of the possible causes of the Yamal sinkhole draws attention to an event that took place April 12, 1991. This is the so-called Sasovo explosion [7]. Its characteristic features:

- flat funnel that resembles a lunar crater with a mound in the middle;
- no significant amount of soil in the presence of its small amount of it on the edges of the crater;
- the unusual nature of the explosion — from the ground to the sky.

The official version of the causes of the explosion initially considered Sasovskoye explosion of nitrate fertilizer, stored in bags in this field. Evaluation of occurred explosion power on basis of the size of the funnel and the volume of discarded soil (at least 30 tons of TNT, and other estimates 300 TNT) was not taken into account. Later, a group of seismologists led by geophysicist E. V. Barkowskiy, researched geotectonic processes in this area and has made a map of tectonic faults. These studies have shown that an explosion or an earthquake more precisely at a shallow depth along the fault has occurred, which started the relative motions of plates. The explosion occurred as a result of the tribo piezoelectric effect, a large accumulation of electrical charge and discharge under conditions of anomalous gravitational phenomena. The scientist explains activation of tectonic processes by the periodic contraction and expansion of Earth's geoid [6].

E. V. Barkowskiy's hypothesis at first glance is quite convincing, but it does not explain the powerful ionospheric phenomena, fireballs, bolides and plasmoids of huge size «walking» over the city, the vast power of the shock wave.

As witness of Sasovo explosion was the whole city, and many documents about this phenomenon are preserved, then let's discuss it in more detail. The researchers did not attempt to find the cause of the sets of related electrical phenomena and their analysis could explain a lot (Table).

Table

Chronology of geophysical and ionospheric phenomena surrounding the explosion in Sasovo April 12, 1991

Electrophysical phenomena	Possible reason
4 hours before the explosion a huge ball of bright white still hovered over the city's train station, and then slowly flew to the northeast	Start strong ionization of the atmosphere and the formation of the plasmoids
An hour before the explosion over the future funnel place there was a strange glow	Most likely it was a corona discharge of negative charges, known as St. Elmo's fire, they are formed by the electric field in the atmosphere of the order of 500 V/m and above, at a rate of 150 V/m
For half an hour before the explosion, two bright red ball crossed the sky. Glowing balls, with the hum dissecting the sky, appeared in 30 km from the epicenter, during their flight the people heard the roar and felt the ground shaking. Just before the city two bright blue flash were observed	It started intensification of ionospheric processes, increasing the number of electrophonic plasmoids and bolides, their number and in shape of a cloud, there was a partial discharge plasmoids due to an increase in the electric field

Electrophysical phenomena	Possible reason
In the sky above the place where there was an explosion, a ball or a cloud was seen, saw a ball or a cloud, emitting bluish glow which it "flew" to the site of the explosion, then at this point there was a bright flash, a pillar of fire appeared and only then there was an explosion	The full picture of the formation of plasmoid cloud and streamers flow coming to it from the earth's surface caused by the preceding electric discharge
At 1:34 a. m. there was a growing roar. The earth trembled. People have a sense of fear. Multi-storey house swayed from side to side, in apartments furniture were falling, chandeliers were scattering in pieces. People were thrown out of the bed. Thousands of windows and doors were knocked out of their sockets. From the incredible pressure road hatches covers were thrown off, light bulbs were burst. Underground water pipes bursting. When the roar of the verse, people heard removes rumble	Activity of tectonic processes is increasing and it is caused by the approach of slow seismic waves, amplifying the natural low-frequency vibration of buildings and structures. Low-frequency vibrations have a psychoactive effect, inducing a sense of fear. There is a release of negatively ionized soil from the explosion site to meet positively ionized bolide or plasma formation in the ionosphere and its discharge, which caused a strong shock wave. At the same time, the electric-underground plasmoids cause water hammer and pipes breaks and shock waves in sewer channels
Above the crater for 10–15 seconds there was a glowing multicolored pillar height of more than five kilometers. After the explosion, a "cloud" with clearly defined edges appeared in the sky, flying against the wind. It shone from inside with the white light. In 3–4 minutes the city observed a round bright red glow that gradually faded	Soil involved in processes ionospheric height climbed upto over 20 km, to velopause zone in which air flows in an opposite direction. After discharging the atmosphere and raised in it ground are gradually cooling
Two nights in a row funnel shone as if it was backlighted from below. Severe headache and dizziness were pouring down the people who dared to come down to it, their electronic watches and calculators ware failing. Some photos were ruined, covered with a strange glare. The glow stopped after water from the river was sent into the funnel	After a powerful electric plasmoid discharge excitation of considerable depth of geo basis occurred, there was the X-ray and possibly γ-radiation, the process choked bay of funnel by water

The table shows that the attention of the official experts and researchers, in spite of the enormous amount of factual material and observations slipped objective assessment of related phenomena, as a possible root cause of this catastrophic event. The cause of the explosion Sasovskoye, Yamal and other failures must be sought not only in the structure of geo basis tectonic faults but in collectively geophysical conditions, and seismic and ionospheric phenomena.

3. The hypothesis of the seismic and ionospheric mechanism of formation dips and crater-like formations of the Earth

Research and hypothesis about the possible cause of such phenomena are given in the article "Plasmoid bolides of cosmic and technogenic origin" [3]. Here, on the basis of other well-known events and phenomena of meteorites fall, the formation of plasmoids and other natural and man-made expressions, the hypothesis of the seismic and ionospheric mechanism of formation of sinkholes-craters is substantiated.

Despite the fact that the electrical and gravitational phenomena accompany almost all earthquakes, their account in explaining the causes of seismic events and even more so in their prognosis is clearly undervalued. Ionospheric phenomena is even more undervalued as the preceding and accompanying factor of earthquakes, but they are considering as only their precursors. It is considered impossible to initiate earthquakes with the help of the local electromagnetic heating of the ionosphere due to the fact that the power and heat energy is less by orders of magnitude then energy of even a relatively weak earthquake.

In [4, 5] the significant role played by the slow seismic waves having a speed of less than 1700 km/h, in the transmission of seismic energy from the earthquake and in the initiation of new seismic and other catastrophic events is shown.

The slow seismic waves are formed and emanate from the epicenter of the earthquake in the form of a wave packet with the following parameters (1), (2), (3):

$$V_n = \sqrt{g \cdot \frac{H_n}{k}}, \quad (1)$$

where V_n — n wave velocity; H_n — the depth of the earthquake source; g — gravitational constant; wave coefficient k = 1, 2, 4, 8, 10, 16, 25, 32, 64, ... 128.

$$\varpi_n = 2\pi\sqrt{g \cdot \frac{k}{H_n}}, \quad (2)$$

where ω_n — the angular velocity of rotation of the wave; H — the depth of the earthquake source; g — gravitational constant; wave coefficient k =1, 2, 4, 8, 10, 16, 25, 32, 64, 128 ....

$$\lambda_n = \frac{H_n}{k_n}, \quad (3)$$

where H_n — the depth of the earthquake source, λ_n — n wave length, wave coefficient k =1, 2, 4, 8, 10, 16, 25, 32, 64, 128 ....

The main physical properties of slow seismic waves is:

1. Diverging waves have ring-wave structure having an outer (front) and internal (tail) portion, rotating in opposite directions.
2. The physical parameters of the waves are determined by the potential, volumetric energy density, wavelength and its forward speed, variable radius and angular velocity.
3. The waves are scalar and do not have a directional force action, but in interaction with the already going physical processes that give them some of their energy, increase them during the passage of the wave front and hinder the passage of the wave tail. The largest cumulative impact on the physical processes is caused by waves at a speed of 30–130 km/h.
4. They cause deviations of local gravity and chronometric characteristics towards both increasing (front) and decreasing (tail). A feature of these waves is the ability to initiate the electric charges.

Based on the characteristics of the physical properties of slow seismic waves, it can be argued that not only overstrained tectonic faults can be the focus of the earthquake, but any lithospheric heterogeneity, always having a certain natural frequency.

If over a local lithospheric inhomogeneity located in a quiet "sleep" state, positively charged ionosphere will be heated by a pulsed electromagnetic radiation and thereby geo basis will be negatively polarized, then these weak natural vibrations can be shaken and strengthened. This will lead to the fact that slow seismic waves from earthquakes occurred on the eve will begin to transmit their energy to the excited structure and after a certain critical value it will cause a local earthquake.

It will be somewhat different is the case when geo basis heterogeneity is not hard enough or has a small size (volume), to save energy and critical enough to cause a major earthquake. In this case, it will be the accumulation of electrical charge, a large-scale phenomenon of plasmoids, shaking the ground and buildings and discharge of accumulated volume and surface electric charge in the form of explosion.

This is what happened in Sasovo, and before that at the Chernobyl nuclear power plant. A feature of Sasovo explosion was that the break, which is a structural heterogeneity, was closed by a significant layer of the millennial relatively loose soil. This led to the fact that there was only a small local earthquake, but powerful electric discharge with an explosive release of soil into the atmosphere.

This phenomenon is possible due to the electric charge mutually induced in the ionosphere and lithosphere and its subsequent discharge with soil thrown up. Funnel formation-crater and release of electroactivated ground to the ionosphere can be a result of even a minor energy local earthquake. This phenomenon can be caused by high levels of negative ionization of the soil and its interaction with the local underground positive charge of the geo basis lower layers. At the first this leads to the underground explosions, and then to release of the remaining negatively ionized soil up to a positively charged ionosphere followed by its discharge and explosion in the atmosphere and a strong shock wave. An earthquake or an explosion-discharge occurs at the time of the passage of slow seismic waves from earthquakes occurring on the eve through this area which energy becomes critical.

What the conditions and processes may cause these catastrophic events?

The root cause of these phenomena is a powerful local plasma formations in the ionosphere. They can be caused by both natural factors during periods of high solar activity, and artificial heating of the ionosphere by means of electromagnetic emitters.

High solar activity is characterized by regular explosions on the sun and positively charged particles releases into outer space — a proton wind. Its interaction with the Earth's ionosphere leads to the formation of large positively charged plasma formations, which are especially noticeable in its polar and subpolar regions as the northern lights.

Local gain and the concentration of plasma formations can occur in two cases:

- when stone bolides entering into the ionosphere;
- over the focus of future earthquake forming.

The bolides with very high brightness can create (for example, by ultraviolet radiation) static charges in the stratosphere of huge quantities — up to 107 coulomb, which are quickly neutralized [2]. Calculations showed that the car increases the electric field strength at the Earth's surface up to 140 V/cm against the normal value of ~ 1.5 V/cm. In these conditions static electricity run-off from some items is possible, it is accompanied by light and sound phenomena (Fig. 4), the appearance of the lights of the St. Elmo lights, small fireballs and hiss.

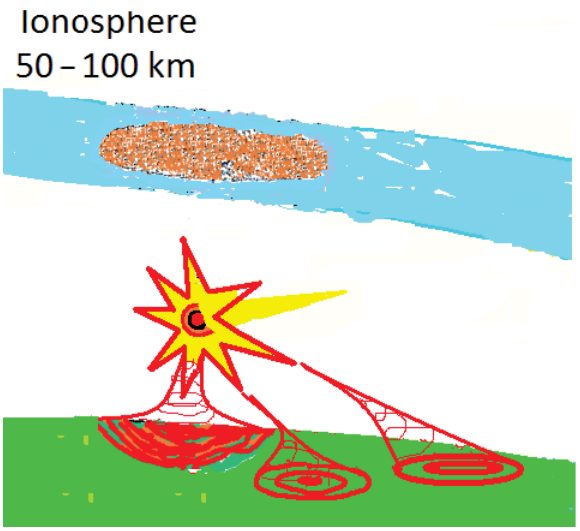

Fig. 4. The formation of the vortex flow of negative electric ions from the surface of the Earth along the lines of the electric field to the positively charged head of the plasmoid bolide

In the future, when a certain level of intensity of the electric field between the bolide and electrified corona surface is reached the bolide flight is accompanied by the release of electrically charged particles of the soil and its discharge with the formation of a strong shock wave (Fig. 5). The consequences of this interaction are residual traces of soil release in the form of one or more "lunar" craters or sinkholes and glow of ground and the atmosphere above them (Fig. 6).

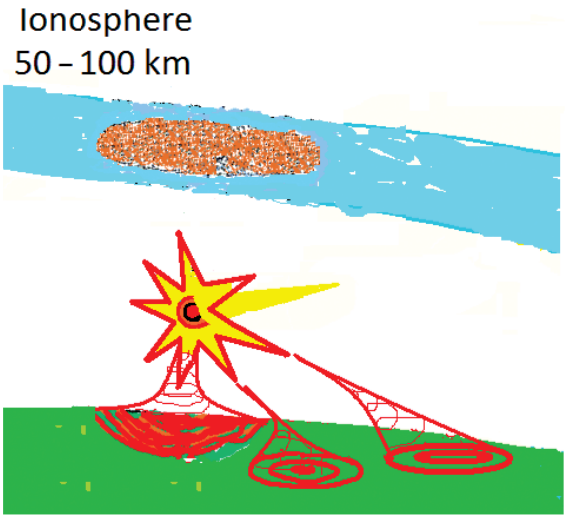

Fig. 5. Plasmoid explosion (electric discharge) after the formation of streamers electronegative with entrainment of soil mass from the surface of the Earth and their interaction with the positively charged warhead plasmoid bolide

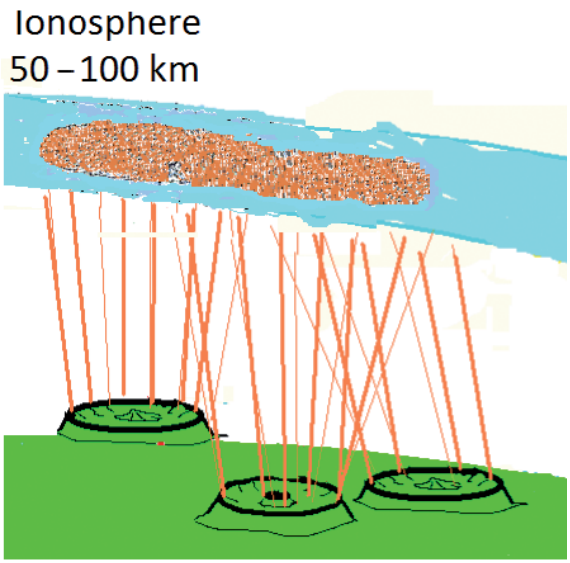

Fig. 6. Residual effects after the electrical discharge and explosion plasmoid bolide: the formation of residual plasma clots in the ionosphere after the action of "ionospheric heaters" and flat "lunar" craters on the Earth's surface caused by the entrainment of soil mass from the surface of the Earth by electronegative streamers and sky glow, sometimes in the form of rays (hours and days) over the area of the plasmoid explosion

In the second case, with the local concentration of plasma formations above the focus of future earthquake, these phenomena are expressed much weaker and therefore are classified as precursors only, but not the initiator and cause of earthquakes. What is difficult to accept, they undoubtedly are the amplifier of energy-exchange processes between the ionosphere and lithosphere, accelerating of forming and energy of earthquake.

The most unpredictable consequences will be in the case of an artificial ionosphere heating by pulsed electromagnetic heating or other physical excitation of plasma formations in the ionosphere (Fig. 6). The unpredictability of the consequences of such interference occurs due to the fact that all the factors that affect the energy and the physical manifestation of the consequences of this intervention are not taken into account.

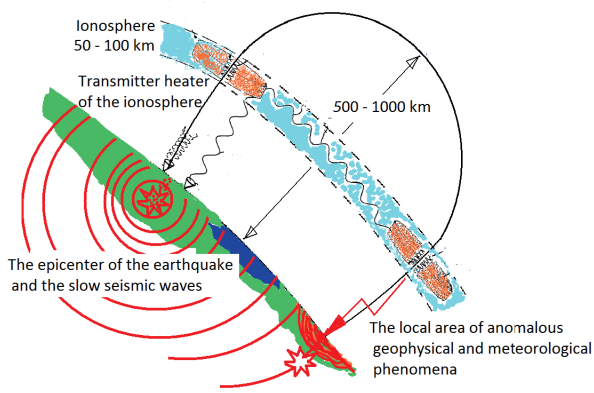

Fig. 7. The physical principle of the "ionospheric heater" HAARP operation in conjunction with the slow seismic SS-waves

In particular, it refers to the power of seismic processes, which energy is not localized in the area of the earthquake source, and distributed throughout the global space of the Earth. This is connected to the properties of slow seismic waves emanating from the foci of earthquakes, and their ability to change the intensity of the physical processes going on any remote area of the Earth. Any physically active process is sensitive to the influence of the waves and cannot be isolated from them. In principle, it is possible to consider the approach and even to measure the parameters of these waves, but taking into account their diversity and quantity from all sources is challenging, as it requires the development of space and geophysical monitoring system.

Conclusion

The reason of Yamal sinkhole is the geoionosfernoe interaction, culminating in an electrical discharge in the ionosphere and expressed in conditions of geo basis features as a structure that combines the permafrost and groundwater, with the possible presence of frozen

and dissolved methane. The energy released as a result of the "failure" or "release" of the soil is comparable to an earthquake of 3 to 3.5 M, which corresponds to 1 to 10 kT of TNT equivalent explosive. But as an earthquake or a corresponding explosion is not recorded by seismic stations, it can be argued that the soil was thrown out and scattered in the upper atmosphere. This phenomenon occurred in a period of high solar and ionospheric activity. Flying and falling fireballs (meteors) in the area at the possible time period is not recorded. It is not possible to take into account the work of the ionospheric heater systems, which include transmitters such as HAARP system, located in Alaska and Norway, as well as the military systems of horizon radar. Therefore, the question about the reason for the local activation of the ionosphere on the Yamal Peninsula is still open.

The most likely cause of the explosion in Sasovo should be considered as technological impact caused by experiments conducted by ionospheric heaters station project "Sura" at that time, which is located in 300 km from Sasovo. This proves the high level of electrification and anomalous atmospheric and powerful plasmoid phenomenon occurred a few hours before the explosion.

The possibility of such catastrophic events is amplified for areas of ancient volcanoes, in particular for the "Yamal sinkhole". There is a hypothesis about the electrophysical and seismic nature of the formation of oil [9]. Therefore, oil and gas deposits areas are zones with the preserved memory and geological structures which are formed as a result of high paleo seismic activity. This also applies to diamond mining areas. Therefore, there are always risks of "downwarping — emissions".

To avoid such catastrophic phenomena in industrial and densely populated areas must be done:

- geophysical studies to determine seismic paleoactivity and paleovolcanoes;
- after identifying such zones it is needed to limit their development and settlement;
- a constant monitoring of ionospheric state, and especially local concentrations of plasma formations and the sources of their origin is required;
- changes of geophysical conditions monitoring is required to determine the response — the sensitivity of the local areas and objects to external influences.

These activities will not only identify the risks of disasters such as Yamal sinkhole and explosion in Sasovo, but also prevent a number of other natural and man-made disasters caused by the same reasons.

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